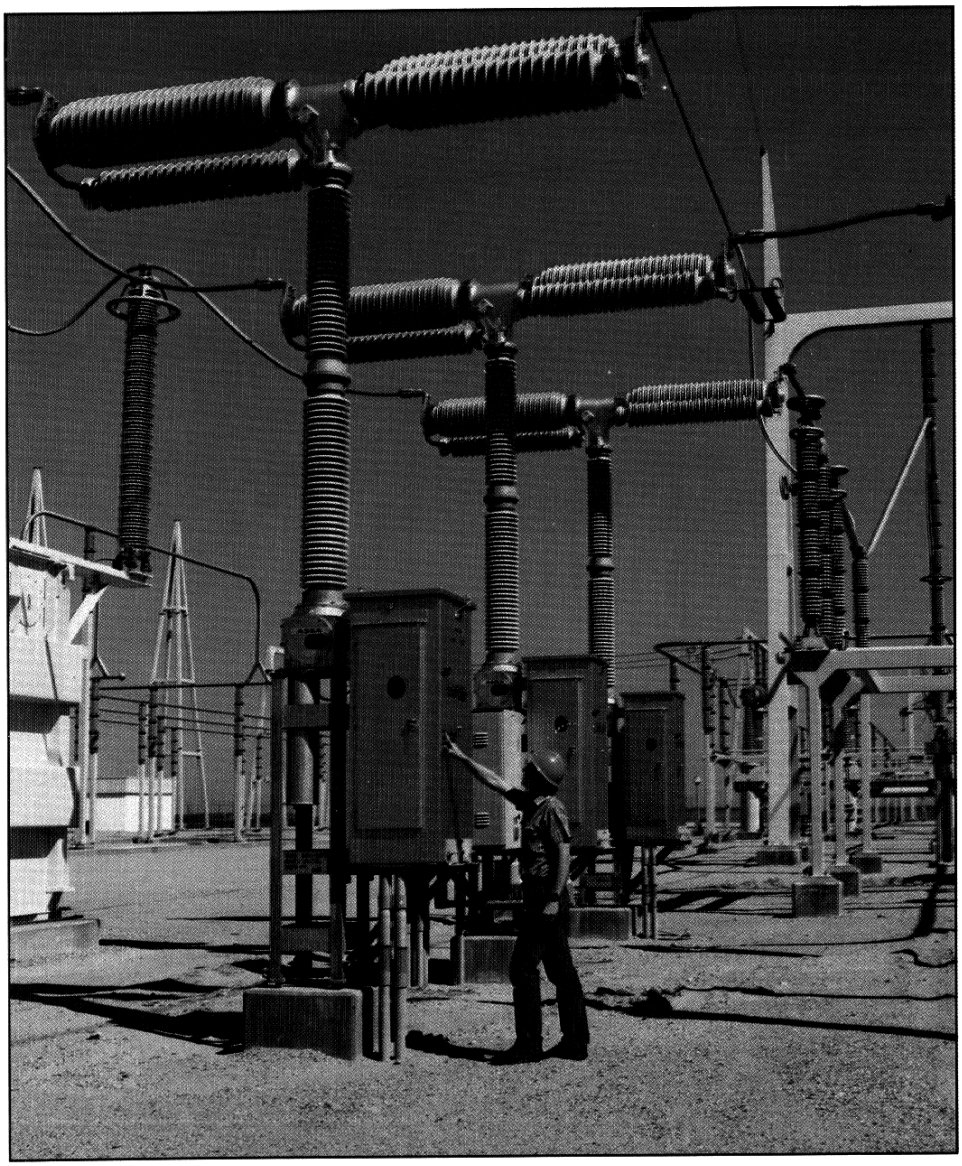
ABB
ASEA BROWN BOVERI

Type HPL
SF_6 Live Tank Puffer Circuit Breaker



Type HPL 362/31B2 breaker installed in a 345 kV Substation in South Dakota

HELPING SHAPE AMERICA'S ELECTRICAL FUTURE

Introduction

The HPL is a live tank SF_6 puffer circuit breaker designed for 69-550 kV and for rated interrupting currents 40 and 50 kA. It is operated by a simple and dependable motor charged spring-operated mechanism. The data in this brochure covers standard circuit breakers 69 to 550 kV and rated currents from 2000 to 4000 amperes.

HPL breakers are normally delivered with three single-phase current transformers and are typically equipped with 2 to 4 relay cores and 1 metering core per phase. For voltage levels of 69 to 145 kV the current transformers are mounted on brackets attached to the circuit breaker stands. For higher voltages the current transformers are mounted on separate stands. HPL circuit breakers are also available without current transformers. For detailed information on current transformers please refer to ABB catalog IMB.

For voltage ratings 69-242 kV, each pole requires only one breaking element for 40kA. (For voltage ratings of 145kV and below the addition of TRV capacitors increase the single breaking elements's short circuit interruption to 50 kV.) Breakers can be equipped with pre-insertion resistors for special applications.

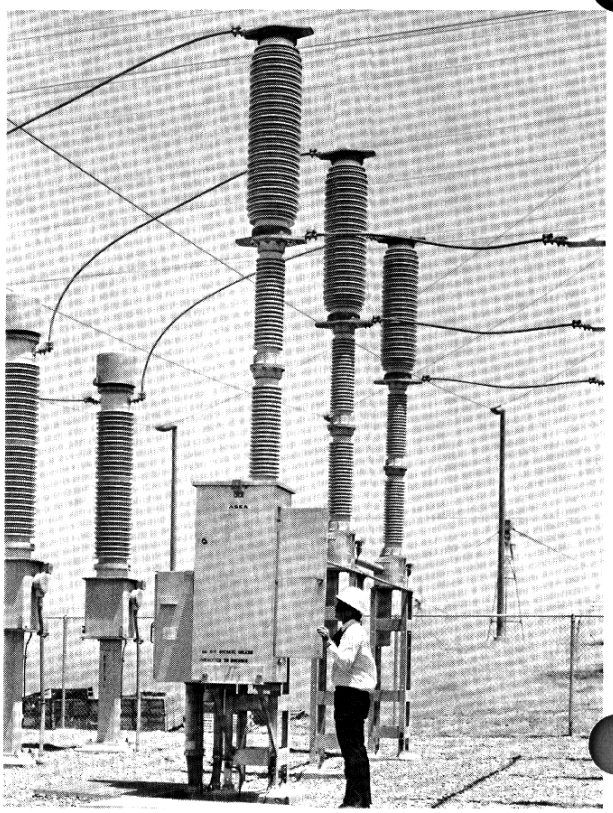


Fig. 2. 245 kV single element HPL breakers with free standing CT's serving a West-Coast substation.

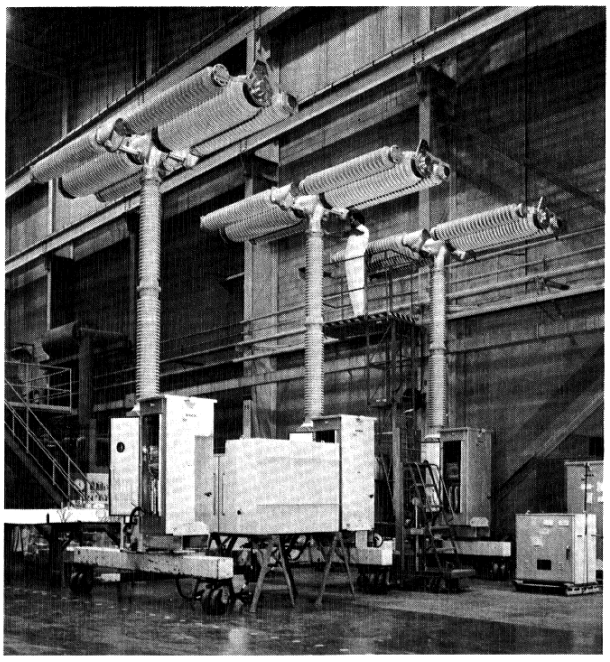


Fig. 1. Type HPL 362T31B2 breaker with pre-insertion resistors being readied for final tests at ABB plant.

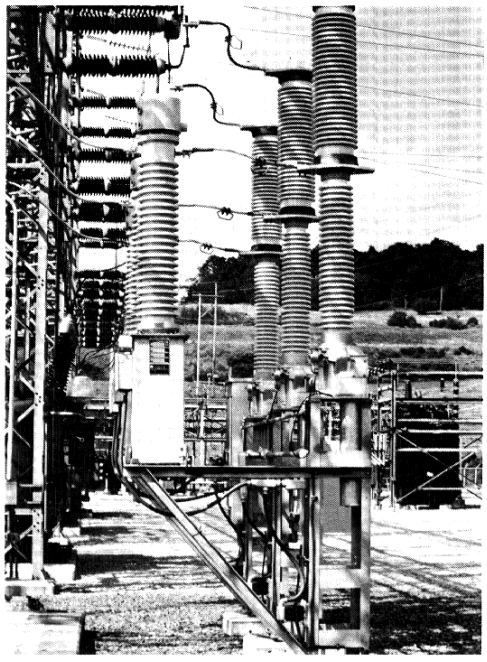


Fig. 3. 145 kV HPL with bracket-mounted CT's.

Breaker Poles

The "pole" includes the interrupting unit with the porcelain supporting insulator and a mechanism housing. The opening spring is attached to the mechanism housing (see fig. 5). When the breaker is closed, the main current flows through the main contacts (fig. 4a).

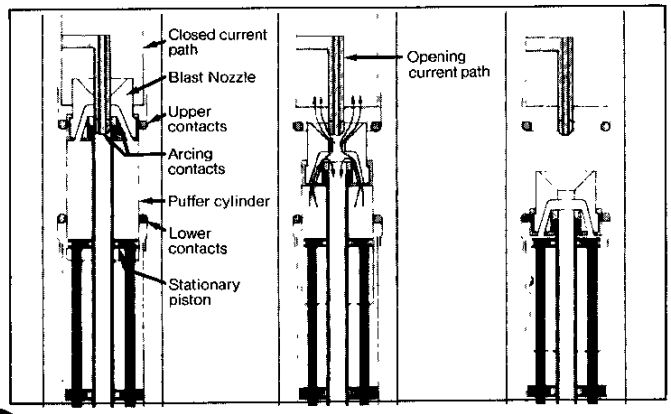
When the breaker opens, the lower moving contact assembly is pulled downward by the insulated pull rod which is operated by the opening spring. The main contact opens first, at which time the current is transferred to the interrupting contacts. This movement compresses the SF_6 gas inside the puffer cylinder.

When the interrupting contacts separate, an arc is established between them. After a few microseconds, the pressure of the compressed gas in the puffer overcomes the blocking effect of the arc, causing a powerful dual blast gas stream to be released, thereby extinguishing the arc (see fig. 4b and c). The nominal SF_6 pressure is 72.5 PSIA (0.5 MPA) at 20°C (70°F). A temperature compensated density monitor gives a signal in the event of a pressure drop to 65 PSIA and it also enables blocking or trip operation at 62 PSIA pressure. Double O-ring seals of nitrile rubber, both at the static seal and at the dynamic seal in the lower mechanism housing, effectively protect against leakage.

Each pole is provided with a dessicant (moisture and decomposition gas absorbing agent) designed for lifetime service without opening the pole.

The guaranteed operating temperature range is -40°C (-40°F) to 40°C (110°F). For applications at temperatures down to -50°C (-60°F) a mixture of SF_6 and N is used (contact ABB for details).

Due to the relatively low operating pressure of the ABB design, no heater is required in the interrupting chambers (as would be the case with designs using higher operating pressures).



(4a) Breaker unit in closed position (4b) Breaker unit during opening operation (4c) Breaker unit in open position

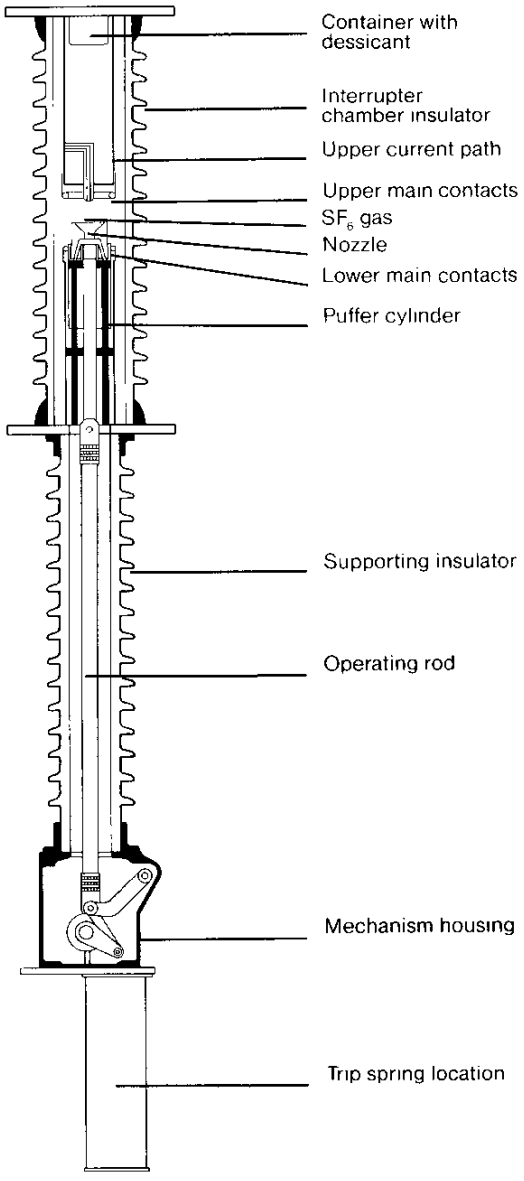


Fig. 5 Puffer operation principle.

Operating Mechanism

The breaker uses a type BLG 1002 operating mechanism. This mechanism allows high speed opening followed by auto reclosing that meets or exceeds ANSI reclosing requirements. A key feature is that the closing springs both close the breaker and charge the opening springs located below each pole.
As soon as a closing operation has been completed, the closing springs are automatically charged by an electric motor, after which an open-close-open cycle can take place. This means that high speed auto reclosing and opening of the breaker is possible.

The main transmission element inside the operating mechanism is an endless chain, which transmits the energy from the motor to the spring assembly on tensioning the springs, and also the energy from the springs to the cam disc (see fig. 6), on closing.

Fig. 7 shows a complete operating sequence of the mechanism. The time necessary for charging the closing spring is approximately 10 seconds, which ensures that the ANSI duty cycle can be met.

The mechanism is electrically trip-free and equipped with an anti-pumping device. Necessary apparatus for operation and supervision is installed in the control cabinet.

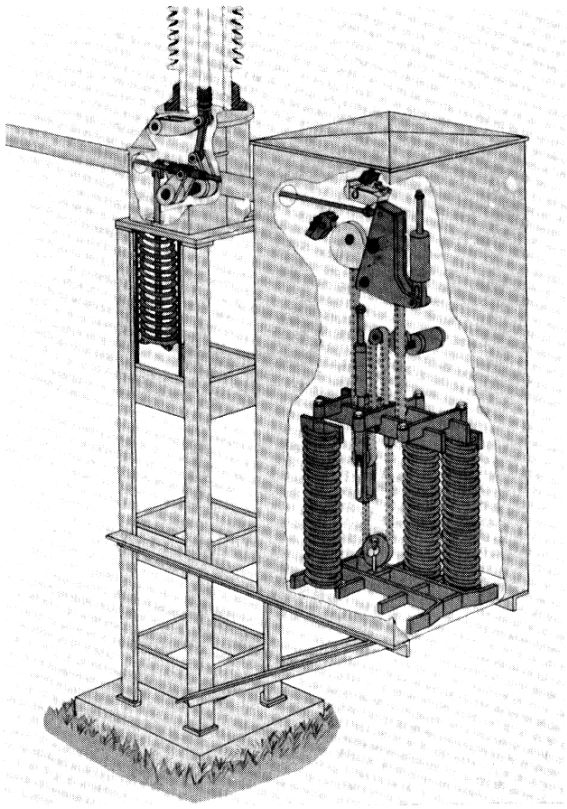
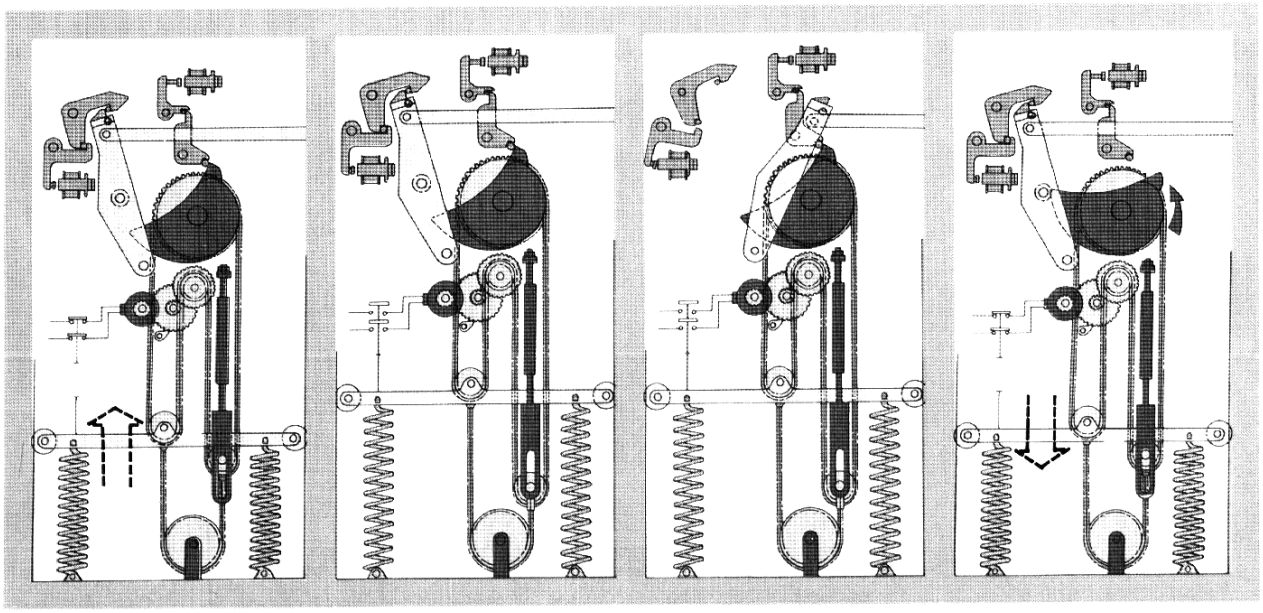


Fig. 6 Operating mechanism.



Breaker closed. Arrow shows motor in process of charging closing springs.

Breaker closed. Here, closing springs are fully charged, with mechanism ready for open-closed-open operation.

Breaker open. Opening spring on each pole opens breaker.

Breaker during closing. Released closing springs rotate closing cam in counter clockwise direction to closed and latched position. Closing springs simultaneously recharge opening springs.

Fig. 7. Operating sequence of the spring-closing mechanism, type BLG.

Operating Mechanism Details

The frame of the BLG 1002 mechanism is constructed of steel and is protected against weather and dust by an aluminum enclosure fitted with gasketed doors. The entire cabinet is weather-sealed and has filters in the upper and lower ventilation openings. One heater of 100W is continuously used to prevent condensation. Another heater of 500W is thermostat-controlled to provide additional heat at low ambient temperatures. An operation counter is visible from the outside, through a window. The mechanism is equipped with one closing coil and one or two opening coils.

A mechanical pushbutton on the outside of the breaker provides emergency tripping. After such tripping a separate switch prevents remote reclosing until separately reset (69 device).

All cabling from the mechanism is led through conduits to the central control cabinet. All cabling for the user is terminated in this control cabinet.

Data				
Universal AC/DC single phase motor 125VDC/120VAC[1]				
Power		kW		2
Voltage		V		125
Starting current at 125VDC		A		60-125
Normal current at 125VDC		A		16.5
Starting current at 120VAC		A		65-90
Normal current at 120VAC		A		16.5
Operating range at 125 VDC		V		90-140
Operating range at 120 VAC		V		104-127
Operating coils 125VDC[1]				
Closing coil	Power consumption	W		200
Closing coil	Operating range	V		90-140
Opening coils	Power consumption each	W		200
Opening coils	Operating range	V		70-140
Operating coils 48VDC (alternative)				
Closing coil	Power consumption	W		200
Closing coil	Operating range	V		36-56
Opening coils	Power consumption each	W		200
Opening coils	Operating range	V		28-56
Auxiliary contacts				
Rated and making current at 125VDC		A		10
Breaking current at DC inductive circuit		A		7.5
Number of contacts available for user when one BLG mechanism per breaker is used.				
Normally open "a"				9
Normally closed "b"				10
Weight		lbs		1050
Heaters		Mechanism		Control Cabinet
Continuously connected		100 W		250 W
Thermostat operated		500 W		250 W

[1]Other voltages also available upon request.

Installation

After delivery, each stand is erected on prepared pads. The breaker poles are checked for any transport damage and then mounted on the structures and filled with SF_6 from a provided gas cylinder.

Site testing is simple, requiring only basic mechanical checks, check of motor currents, and check of opening and closing times.

Erection and testing of a 145kV breaker can normally be accomplished within a single day by a crew of three, using a small (one-ton) crane. ABB will provide a supervisor at the request of the customer. For detailed instructions, please see the erection manual.

Control Cabinet

The central control cabinet can be equipped with relays and indicating lights per customer specifications.

Technical Data

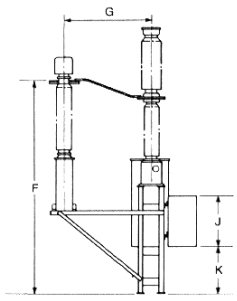
	Unit	HPL 72.5/25A1 and 72.5/31A1	HPL 123/25A1 and 123/31A1	HPL 145/25A1 and 145/31A1	HPL 170/25A1 and 170/31A1	HPL 245/25B1 and 245/31B1	HPL 245/31A2	HPL 362/31B2	HPL 550/31A4
Rated max. voltage	kV	69	121	145	169	242	242	362	550
Insulation withstand test voltages									
Low frequency 1 min. dry	kV rms	160	260	310	365	425	425	555	860
Low frequency 10 sec. wet	kV rms	140	230	275	315	350	350	N.A.	N.A.
Impulse 1.2/50μs full wave	kV peak	350	550	650	750	900	900	1300	1800
Impulse 1.2/50μs; chopped 2μs	kV peak	452	710	838	968	1160	1160	1680	2320
Impulse 1.2/50μs; chopped 3μs	kV peak	402	632	748	862	1040	1040	1500	2070
Creapage distance to ground normal	inches	64	99	112	112	162	179	250	373
Creapage distance across pole normal	inches	102	102	102	116	217	232	422/413	463
Rated continuous current	A rms	← 2,000 3,000 →					3,000 4,000	2,000 3,000	3,000 4,000
Rated short circuit interrupting current	kA rms	40	40	40	40	40	50	50	50
Short time current 3 sec.	kA rms	40	40	40	40	40	50	50	50
Latching current	kA peak	100	100	100	100	100	125	125	125
Interrupting time	cycles	← 2.3/2.0* →							
Closing time	cycles	← 5.5 →							
Rated reclosing time	cycles	← 20 →							
Rated permissable tripping delay	sec.	← 1 →							
Duty cycle (per ANSI)		← O-CO – 15 sec – CO →							
Capacitance switching open wire	A	160	160	160	100	200	200	315	500
Capacitance switching isolated	A	315	315	160	100	200	400	500	500
SF_6 pressure at 20°C (70°F)	psia	← 72.5 →							
SF_6 min. pressure at lockout	psia	← 65/62.5 →							
Max. ambient temperature	°C (°F)	← 40(110) →							
Min. ambient temperature	°C (°F)	← −40(−40) →							
SF_6 gas in one pole	lbs.	7	7	7	8	14	14	22	32
Weight per pole (except steel stand)	lbs.	800	900	900	1050	1630	2700	3700	7000
Dimensions	A	2′-2⅜″	3′-9⅛″	4′-2⅜″	4′-2⅜″	5′-11½″	5′-11½″	9′-5½″	Information on request
	B	3′-9⅛″	3′-9⅛″	3′-9⅛″	4′-3″	5′-7¾″	5′-7¾″	—	
	C	11′-6⅜″	13′-1⅛″	13′-6⅛″	13′-6⅜″	15′-4½″	19′-9¾″	—	
	D	16′-⅛″	17′-6⅞″	18′-⅛″	18′-6⅛″	21′-9⅜″	21′-2″	20′-9¾″	
	E	4′-5⅛″	8′-2½″	8′-2½″	8′-2½″	11′-5¾″	10′-6″	16′-0″	
	F	11′-1⅜″	13′-10¼″	13′-10¼″	13′-1½″	16′-7¼″	—	—	
	G	5′-8⅞″	5′-8⅞″	5′-8⅞″	11′-5¾″	11′-5¾″	11′-10½″	14′-7⅜″	
	H	7′-2⅝″	7′-2⅝″	7′-2⅝″	7′-2⅝″	7′-2⅝″	7′-2⅝″	7′-2⅝″	
	I	8′-11¾″	8′-11¾″	8′-11¾″	8′-11¾″	8′-11¾″	8′-11¾″	8′-11¾″	
	J	3′-4″	3′-4″	3′-4″	3′-4″	3′-4″	5′-3⅜″	4′-0″	
	K	3′-1″	3′-1″	3′-1″	3′-1″	3′-1″	3′-6¼″	3′-1″	

* 2.3 cycles is standard; 2.0 with booster trip coil.

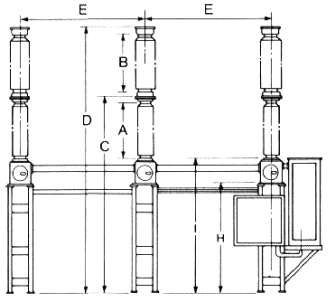
Nomenclature:

- HPL designates any ABB SF_6 puffer-type breaker.
- First numeral designates voltage class (eg. 72.5 = 72.5 kV).
- Second numeral designates continuous rated current of breaker (Example: 25 = 2500 amps rms). Note: For 2000 amp ANSI applications, specify 25 (2500 amp) ABB breaker; for 3000 amp ANSI, specify 31 (3150 amp. ABB breaker).
- Next letter-designation identifies ABB design series (A or B) and is for manufacturer use only.
- Final digit indicates number of interrupters per phase. (Example: 2 = two interrupte r elements per phase).

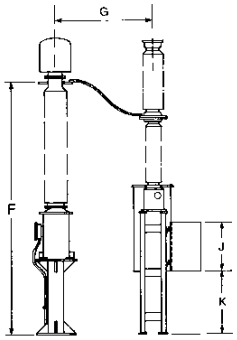
HPL 72.5/25A1
HPL 123/25A1
HPL 145/25A1



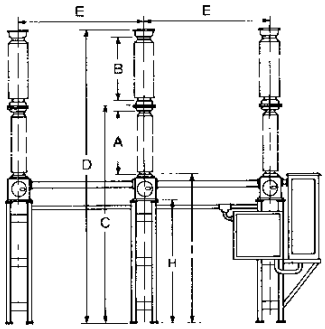
HPL 72.5/31A1
HPL 123/31A1
HPL 145/31A1



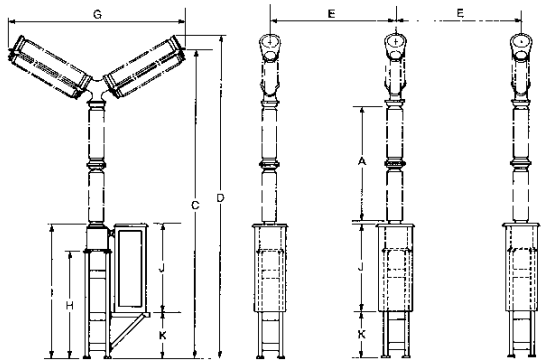
HPL 170/25A1
HPL 245/25B1



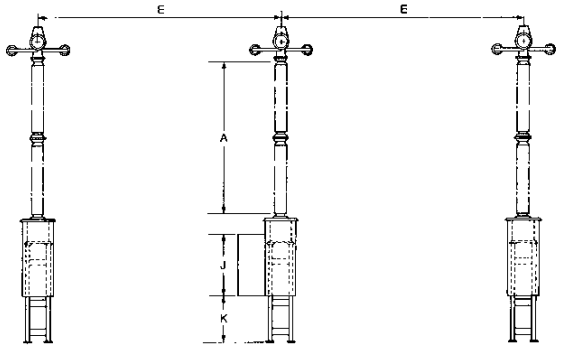
HPL 170/31A1
HPL 245/31B1

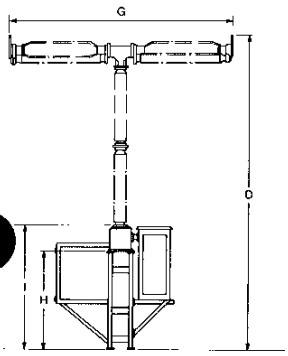


HPL 245/31A2



HPL 362/31B2





Current Transformer Data

Current transformers used on HPL breakers are either of the ABB type IMBD (maximum 1600 A continuous current), or IMBE (for currents higher than 1600 A). Typically each phase has 2 to 4 multi-ratio relay protection cores of either C400 or C800 class. A metering core is also available. For detailed information please see ABB Catalog IMB.

Each current transformer is equipped with a terminal box mounted directly on the tank. The wiring from each terminal box is passed through conduits to the central control box erected on the circuit breaker pole stand.

The breaker, including current transformer, can be equipped with a ground fault CT electrically connected between the stands and ground.

Design Tests

Design tests have been performed to verify conformance with the preferred standard ratings listed in ANSI C37.06, Table 5.

Production Tests

All manufacture and assembly operations follow a stringent quality assurance program set up by ABB. Each breaker is tested in accordance with the applicable recommendations of ANSI C37.09.

Delivery

HPL breakers are produced at the ABB Greensburg, PA plant and are delivered by truck FOB to the customer's site. Each pole, CT housing, and mechanism is carefully crated. The poles are delivered filled with SF_6 at a pressure slightly over atmosphere.

Tools and Spare Parts

SF_6 gas is supplied in a sufficient amount for filling at site.

The following equipment is required for installation:
- basic standard tool kit
- SF_6 filling hose with regulator and gauge
- an electronic timer for checking operating time

The SF_6 filling hose, complete with regulator and gauge, plus the timer, are available for purchase from ABB.

Spare parts are available from ABB stock.

Principal Features and Benefits of HPL Breakers

Live Tank Design

All HPL breakers are of the live tank design. This design incorporates a number of important features with the following benefits to the user:

Feature	Benefit to user
Low weight	Easy installation, low foundation costs
Small breaker head dimensions	Maintenance or replacement, if required, is simple
Small SF_6 volume	Easy and low cost gas replacement, if required
Full insulation distance to ground	Full BIL to ground in case of loss of SF_6 pressure
Modular concept	Common interchangeable parts and modules

Proven Interrupter Design

The SF_6 interrupter design used by ABB has proven itself in thousands of installed units since its introduction in 1975. These installations have involved both HPL breakers and ABB gas insulated switchgear. Their features and benefits include:

Feature	Benefit to user
Low static pressure	No risk of condensation at temperatures down to −40°C (−40°F). No heaters required.
Low pressure puffer	Reduced mechanical stress at puffer operation means increased endurance.
Double O-ring sealing system	Reduced risk of leakage
Separated load and interruption contacts	Continuous current ratings thru 4000 amperes. Increased operation endurance.

NOTE: ABB reserves the right to change the design and/or modify the specifications in this publication without notice.

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Simple Operating Mechanism

The operating mechanism used on HPL breakers is of the motor-operated spring-type BLG. More than 12,000 of these units have been installed worldwide since 1970.

Feature	Benefits to user
No pneumatics, no hydraulics	No leakages, no complicated adjustments or maintenance
No compressors	No risk of compressor failure
Simple mechanical design	Simplicity means reliability, simple maintenance

Current Transformer Features

Current transformers of the type provided on HPL breakers have been in production since 1945. More than 65,000 units are in operation worldwide. The primary winding is insulated with special oil impregnated paper interleaved with capacitor layers of aluminum foil (no semi-conducting material is utilized). The primary winding is typically a U-bend capacitive bushing. The cores are permanently clamped onto the insulated primary connector at the bottom of the unit ensuring correct position and lifetime measuring accuracy.

Maintenance

Inspection of the operating mechanism is recommended after the first year. Each 6 to 8-year period, cleaning, renewal of anticorrosion protection, lubrication of moving parts, check of oil in dashpots, and a check of operating values is recommended. Each 12 to 16 years, or after 2000 operations, a more detailed check is suggested.

The internal parts of the pole are designed to endure approximately 20 operations at full 40 kA short circuit. At lower currents, the endurance increases significantly (see figure 8).

For detailed maintenance instructions, please see the maintenance manual.

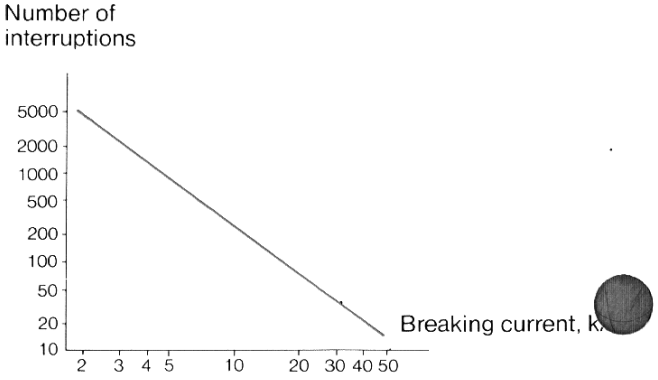

Fig. 8 Endurance for various breaking currents.